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INCLUDING

A DISCUSSION OF THE DIGESTIBILITY OF THE RATIONS.
THE EFFECT OF MEAL ON THE DIGESTIBILITY OF HULLS.
THE FERTILIZING CONSTITUENTS OF THE RATIONS RECOVERED IN THE MANURE.

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RALEIGH, N. C.

COTTON-SEED HULLS AND MEAL FOR BEEF PRODUCTION

INCLUDING

A DISCUSSION OF THE DIGESTIBILITY OF THE RATIONS.
THE EFFECT OF MEAL ON THE DIGESTIBILITY OF HULLS.
THE FERTILIZING CONSTITUENTS OF THE RATIONS RECOVERED IN THE MANURE.

BY F. E. EMERY, AGRICULTURIST, AND B. W. KILGORE, ASSISTANT CHEMIST.

The subject of feeding cotton-seed hulls for the production of beef has been studied before by this Station and from different standpoints. "Will it pay?" is one of the standard questions. "When will it pay?" is another and "How should the animal be fed to pay?" is still another of the questions often asked. Partly to answer these, for the benefit of the feeders of the State, experiments were begun here as early as October, 1889. Trial after trial has been made and farmers and business men have followed these experiments, as well as conducted some of their own, and many have been led to believe that "it does pay," if not in net cash, at least in the value of the manure which the steers leave behind after the fattening has been completed.

Hand in hand with the feeding experiments, digestion experiments have been conducted since the first year. The digestibility of the rations fed have been determined for cotton-seed hulls alone, and fed with meal at the rate of 7 of hulls to 1 of meal, down in constantly narrowing ratios of hulls to meal, until the rations fed in the trials reported in the present bulletin have reached the narrow proportions of 2 pounds of hulls to 1 of meal and 1½ of hulls to 1 of meal. The first ration of hulls alone was not a maintenance ration. The next was a little more than a maintenance ration, in which hulls and meal were fed and eaten in the ratio of 7 to 1, respectively. The changes of rations have brought changes in results from slow to faster fattening. The digestion work has afforded the key to the reason for these changes, and has given us some valuable additions to the previous knowledge of the subject. The present experiments have been designed as the closing ones of these dual series. The highest, or heaviest, feeding of cotton-seed meal yet attempted for any considerable time, so far as we are aware, has been done in these experiments, and successfully too. The results in some respects

surpass most sanguine expectations. That steers could be induced to eat day after day for weeks and months nearly one pound of dry cotton-seed meal for each 100 pounds of live weight, with no perceptible break in health or appetite, would hardly have been expected. Yet this was done. The feeding during the whole time was on the ratios named, or very near those ratios, and for some time before each of the digestion periods there was no waste, *i. e.*—the steers ate all the food offered them. More was not offered after these rations were determined, because each had been gauged as near his capacity as it seemed possible to reach.

The Steers and the Rations Fed to Them.

Steer No. 1 was a mature ox, which had been worked. He was of a decidedly beef form and was quiet and docile in confinement. Steer No. 2 was also a mature ox, that doubtless had done much hard work. The narrow sloping shoulders, high spine, narrow hips, and sharp angular appearance indicated other than the kindly feeder, yet this steer ate his rations well and made a very creditable gain in weight. Nos. 3 and 4 were young, 2½ to 3½ years old. They were from southwestern Virginia, showed no appearance of having been worked, and were apparently grade shorthorns, though of rather a long-legged type. No. 3, was evidently older than No. 4, and weighed, at the beginning of this experiment, 135 pounds more than did No. 4.

All four steers were being fed a fattening ration of cotton-seed hulls and meal when purchased and were considered fat steers for the Raleigh market. They were, therefore, put at once on heavy rations of cotton-seed hulls and meal, such as is purchased in bulk at the Raleigh Oil Mills. Presumably, they are the same at every other mill, excepting some slight differences in the cleanness of the operation of freeing the kernels or "meats" of the cotton seed from the hulls, on the one hand, and the finer hulls from the kernels, on the other. These materials were intended to be fed to steers Nos. 1 and 2 in the proportion of two pounds of hulls to one of meal, and in quantity sufficient to be considered all they would eat, yet not enough to cloy the appetite. As fed, these steers received rather too much, at first, after which the amount of food per day was reduced; then again slightly advanced. Steer No. 3 was fed in nearly the same way, except in different proportions, while No. 4, was started on a little less than his appetite demanded, and a slight advance in food was the only change needed. These two steers, Nos. 3 and 4 were fed a ration consisting of cotton-seed hulls and meal in the proportion of 1½ to 1. The feeding began Jan. 9, 1894, and continued to April 15, for Nos. 1 and 2, 96 2-3 days; and to May 24th, for Nos. 3 and 4, 135 days.

The Result of the Feeding.

The steers were fed and ate in pounds as follows:

		Steer No. 1.	Steer No. 2.	Steer No. 3.	Steer No. 4.
Cotton-seed hulls fed		1775.	1569.	2018.	1905.5
Cotton-seed meal fed		899.8	787.5	1350.25	1272.3
Cotton-seed hulls eaten		1661.3	1508.8	1872.4	1771.
Cotton-seed meal eaten		897.	786.21	1272.3	1138.
More fed than eaten in 96⅜ days,	hulls	112.7	60.2		
	meal	2.75	1.35		
More fed than eaten in 135 days,	hulls			145.6	134.5
	meal			78.0	130.5
Daily rations eaten for entire experiment,	hulls	17.2	15.6	14.1	12.4
	meal	9.3	18.	9.6	8.3
Valuing cotton-seed hulls at $3 and meal at $24 per ton, with 66 cents for hauling, and calculating on what was fed to each steer, the balance is,		Net loss $0.28	Gain $ .70	Loss $10.17	Loss $6.03
But on the basis of what was eaten, the balance is,		Net loss $0.07	Gain $.81	Loss $7.08	Loss $4.82

These were long feeding periods for animals in the condition in which these were at the beginning of the experiment. Steers Nos. 1 and 2 gave a net profit of 74 cents on basis of cost of food for 96 days' feeding; $3.12 for 81 days' feeding, and $5.71 for 63 days' feeding. Steers 3 and 4, on the heavier ration of hulls and meal, gave a net loss of $11.90 on basis of cost of food eaten for 135 days, while for 40 days' feeding there was a profit of $1.83. Steer No. 3 first showed loss in the period of 22 days from the 40th to the 62d day, while No. 4 had only lost $0.05 after 81 days. Perhaps, then, one of the most valuable points in the experiments is to be found in indicating the times at which the feeding might have closed with the greatest profit to the feeder. The above figures do not take into account the cost of feeding (as to time, etc.,) and the value of the manure.

The above summary shows that, although considered fat cattle when purchased, the gain in weight and increase in value from bettered condition paid for over 40 days' feeding of No. 3 and about 80 days for No. 4, and at least 96 days for Nos. 1 and 2. A fall in the price of cotton-seed meal from the date of feeding to publication would show, on re-calculation of the cost, a net profit on No. 1 of $2.42 or $2.62, and on steer No. 3, a gain of $3.06 or $3.17, according as the food fed or eaten is made the basis of calculation. The same re-calculation for steers Nos. 3 and 4, would show a reduction of the loss to $6.12 or $2.26 for No. 3, and $3.80 or $3.42 for No. 4. Had the feeding been stopped earlier, the results would have been more favorable. The heavy rations are thus shown to have been profitable with these half fat cattle only for two or three periods, comprising 40 to 63 days. A much poorer ration could not have been depended on for profit from the best conditioned steers. They had been pre-

viously fed and were to be sold as fat cattle. Any further feeding must have been better than the former in digestible matter, in order to support the weight already attained and to add more to it. The rations here fed, proved to have been equal to the demand, as a profit accrued from the 40 to 60 days' feeding. A table of rations was calculated for each steer in every period, showing length of period, average weight for each period, pounds of hulls and meal eaten, dry matter per 1,000 pounds, and the digestible protein, carbohydrates, and fat eaten by each animal. These are given in detail in the complete record of the test in the complete bulletin herewith. The pounds of nutritive substance per 1,000 pounds, the nutritive ratio, actual daily gain, and gain per 1,000 live weight are also included.

The Temperature of the Stable.

With this experiment, an accurate record of the temperature of the stable has been taken by a Draper's Self-recording Thermometer. Our climate is temperate and housing stock tends to level the range of temperature. Yet there has occurred quite a range of temperature, and cold has been intense enough to freeze in the stable and make it an uncomfortable place. During the feeding reported in this bulletin, the following temperatures and averages in degrees Fahrenheit were recorded:

	1st Period.	*2d Period.*	*3d Period.*	*4th Period.*	*5th Period.*	*6th Period.*	*7th Period.*
Average daily temperature	48.9	48.9	55.1	60.8	61.0	69.8	71.9
Average maximum daily temperature	60.	64.8	65.1	77.0	73.	76.4	81.0
Average minimum daily temperature	35.1	37.4	33.2	38.8	52.4	59.8	61.3
Highest temperature reached	66. Jan. 24	70. Feb. 9	71. Mar. 8	85.5 Mar. 22	80.5 April 19	85. May 2	89.5 May 18
Lowest temperature reached	33.5 Jan. 26	32.5 Feb. 5	30. Feb. 25	33. Mar. 27	47. Apr. 11	54. Apr. 24	54. May 20
Range of temperature	32.5	37.5	41.	52.5	33.5	31.	35.5

The greatest range within a short time was occasioned by the March freeze, when from the 22d to the 27th, the thermometer indicated a range of temperature of 52.5° F. The close approximation to the freezing point in each of the first four periods indicate that stock would suffer if not well housed.

Water Required per Pound of Dry Matter of Food.

Some notes additional to those heretofore reported have been recorded from these experiments. The steers consumed daily an average of 2.96 to 3.42 pounds of water for each pound of dry matter during their whole feeding time. More water was required during the warm than the cool periods. There is no regular relation here between the gain and ratio of water to dry matter consumed.

Digestibility of the Rations.

An average of 55 per cent. of the dry matter was digested in the ration of 2 pounds of hulls to 1 of meal, and 56 per cent. of the ration of 1½ pounds of hulls to 1 of meal. This is a good rate of digestibility, especially when the low digestibility of hulls is considered. To ascertain how the food actually digested in these rations would compare with the amount indicated to be digestible by calculating on a basis of the coefficients of digestibility of the single foods, the digestible matter in the ration of steer No. 2 (2 of hulls to 1 of meal) for the third period was calculated in the usual way, by using the coefficients of the single foods, and compared with what was actually digested in the ration. The actual digestibility of protein and fat were found to be less than the usual method of calculation would indicate, while the carbohydrates were sufficiently more digestible in the rations to increase the total digestible substance in the daily ration nearly one-half pound. Carrying this calculation to 3,000 pounds food, one ton of hulls and one-half ton of meal, there would be a gain of about 50.7 pounds digestible nutrients in the combinations as actually digested over the calculated results. This would argue that cotton-seed meal has favorably affected the digestibility of cotton-seed hulls in the rations.

Does Cotton-seed Meal Affect the Digestibility of Cotton-seed Hulls?*

Using the coefficients for cotton-seed meal† obtained by us, the digestibility of cotton-seed hulls in the various rations with meal has been calculated. The calculated digestibility of the hulls in the rations is greater, in every case, and in some instances materially more, than the average of four determinations show them to have been when fed alone. There has been a decided retardation in the digestibility of protein in every case, due to the combinations. But the loss in protein is more than counterbalanced by the increased digestibility of carbohydrates. The gains in nitrogen-free extract and crude fiber were sufficient, after bringing up the loss from protein to increase the digestible dry matter from .81 per cent. in the 7 to 1 ration of hulls and meal, to 8.66 per cent. in the 3 to 1 ration. This is quite a decided and important increase. In the light of these experiments, we cannot but answer otherwise than that cotton-seed meal does affect and increase the digestibility of cotton-seed hulls.

Fertilizing Constituents of Rations of Cotton seed Hulls and Meal Recovered in the Manure.

It is often stated that the largest, and not infrequently the only profit, from feeding fattening animals, is in the judicious handling of

*For similar discussion and data relating to corn silage, see N. C. Experiment Station Bulletin 97, p. 123.

†N. C. Experiment Station Bulletin 97, p. 116.

the manure produced. To emphasize this, the fertilizing constituents in the various rations of hulls and meal, and the proportion of them recovered in the manure, have been determined by analyzing the foods fed and the manure excreted (dung and urine.) These results show that an average of 90 per cent. of the total fertilizing constituents contained in the rations were excreted in the manure, corresponding to 89.8 per cent. of the fertilizing value; that 42.5 per cent. of these constituents were contained in the urine, corresponding to 50.2 per cent. of the money value; while the dung contained 47.5 per cent. of the fertilizing constituents, corresponding to 39.6 per cent. of the original manurial value of the rations. These figures make apparent the value of urine as a fertilizer, especially where nitrogenous rations are fed. The urine is especially rich in nitrogen and potash, while most of the phosphoric acid is contained in the solid excrement. The average value of the urine per day for five animals was 7.14 cents, against 5.63 cents for the solid excrement for the same time and animals. The value of the manure depends on the foods fed.

The obtainable manurial value of the rations is in all cases materially greater than the original cost of the foods making the rations. The average cost of the daily rations of the five animals was 9.53 cents, valuing cotton-seed meal at $18.00 and hulls at $3.00 per ton. The average total manurial value of the same rations was 14.22 cents, and the obtainable manurial value 12.77 cents. The obtainable manurial value of the rations (12.77 cents) is 134 per cent. of the original cost of the rations (9.53 cents). It is as though the growth and fattening of the animals were obtained for nothing and there was still a balance of 34 per cent. of the original cost of the foods in the manure pile to the credit of the feeder. These results would not be obtained in ordinary practice, since no account is taken of the unavoidable loss in handling and resulting from decomposition. Neither do these figures take into account the cost of feeding and applying the manure to the land.

[The previous pages present a condensed Summary of the several subjects treated in this Bulletin. The detailed and technical account can be found in the following pages (225 to 253). Persons who do not receive these latter pages can be supplied by making application to Dr. H. B. BATTLE, Director, Raleigh, N. C.]